Recovery plan for the Boggomoss Snail *Adclarkia dawsonensis*

Prepared by Dr John Stanisic, Queensland Museum

Australian Government

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Environmental Protection Agency

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Executive summary

Species description and taxonomy

The boggomoss snail *Adclarkia dawsonensis* is currently the only described species in the genus. The boggomoss snail is a medium-sized snail characterised by a relatively thin, semi-transparent shell.

Current species status

The boggomoss snail *Adclarkia dawsonensis* is listed as 'Critically Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Habitat and distribution summary

Living populations of *Adclarkia dawsonensis* are currently known from only two localities in the Greater Taroom area. One is situated adjacent to a boggomoss (artesian spring) on Mt Rose Station. A second, and seemingly more robust population is present on a camping and water reserve on the Isla-Delusion crossing of the Dawson River approximately halfway between Taroom and Theodore.

Threats summary

Given the paucity of records for the boggomoss snail it is difficult to accurately speculate on the previous abundance and distribution of the species. However it has been suggested that the snail has undergone a severe reduction in numbers. This reduction in numbers is an inference based on the almost total destruction of its preferred habitat - riparian on alluvial flats in the Dawson River Valley. In the past, it is suspected that the boggomoss snail was much more widely spread on these flats, but these have been largely cleared for farming. The following threats to the snail's habitat have been identified:

- Land clearing
- Fire
- Cattle grazing
- Weeds
- Earthworks
- Interruption to water flow
- Inundation

Recovery objective

The overall objective of this recovery plan is to manage and protect the boggomoss snail and its habitat.

Summary of actions

The major actions of this recovery plan include; assessing the weed problem and controlling if necessary; developing and implementing a fire risk management plan; fencing the habitat critical to the survival of the snail to exclude cattle; and protecting the habitat of the snail through a voluntary conservation agreement with the landowners. Additional knowledge and understanding of the species is required. This will be achieved by: searching for additional populations of the species; determining the impact of other threatening processes; monitoring known populations of the snail; researching the genetics of the snail; and researching the ecology and life cycle of the snail. Increasing public and landholder awareness of the snail will be achieved through the media, brochures and extension activities.

1. General information

1.1. Conservation status

The boggomoss snail *Adclarkia dawsonensis* Stanisic, 1996 is currently listed as 'Critically Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.2. International obligations

No international agreements currently list the boggomoss snail. This recovery plan is consistent with Australia's international obligations.

1.3. Affected interests

The persons and organisations directly involved with the ownership of the land on which the boggomoss snail occurs are the owners of Mt Rose Station, via Taroom and the owners (Queensland Department of Natural Resources and Water (DNR&W) and current lessees of the Camping and Water Reserve (RES 43) at the Isla-Delusion crossing of the Dawson River. Both the owners of Mt Rose Station and DNR&W were consulted during the development of this recovery plan. In addition, the Fitzroy Basin Association Natural Resource Management Regional Body (FBA) was provided with a copy of the plan for comment and have indicated support for the plan.

Affected government authorities, organisations and individuals may include:

- Taroom and Banana Shire Councils
- Queensland Department of Natural Resources and Water
- Queensland Department of Education and the Arts
- Rural Fire Service
- Landcare and other community groups
- Fitzroy Basin Association Natural Resource Management Regional Body

1.4. Consultation with Indigenous people

There has been no indication that the species is significant to local Indigenous people. The Gurang Land Council was provided with the opportunity to comment on the recovery plan. No comment was received however traditional owners will be encouraged to be involved in further consultation and implementation of recovery actions where appropriate.

1.5. Benefits to other species or communities

The nature of the landscape near the Dawson River at Taroom is generally that of land cleared for pasture, crops and cattle grazing. This is particularly the case with the alluvial flats and riparian environments along the Dawson River. In many areas along the Dawson River between Taroom and Theodore vegetation is, in most cases, cleared to the edge of the river levee. This clearing has had a marked impact on local biodiversity. The Camping and Water Reserve (RES 43) at the Isla-Delusion crossing of the Dawson River is an exception and represents an environment that is reasonably undisturbed. Hence, any management plans aimed at preserving the population of the boggomoss snail at this site will have significant benefits for other flora and fauna, not only at this location but also for the greater Taroom area. The boggomosses of the Dawson also conserve a range of unusual flora and fauna and continued preservation of any of these environments would similarly have an

'umbrella' effect for a range of local biota. Much of the boggomoss snail's range falls within the 'Of Concern' Regional Ecosystem 11.3.3 (Sattler and Williams, 1999).

1.6. Social and economic impacts

Implementation of the recovery plan will have minimal social and economic impacts on the local or broader community. The Mt Rose site will require co-operation of the landholder, which has already been forthcoming. Dedication of this site as a Nature Refuge would have little economic impact based on its comparatively small size and current status as unusable agricultural and grazing land. There is potential for a positive economic impact because the landholder may be eligible for land tax and transfer duty reimbursement under the NatureAssist program.

The management of the Isla-Delusion site will need to incorporate the interests of the two parties currently involved in the ownership and use of this site. The reserve is Crown land under the jurisdiction of DNR&W but the lessee has other propriety rights under the company's lease agreement.

2. Biological information

2.1. Description of species

The boggomoss snail *Adclarkia dawsonensis* is currently the only described species in the genus. Material in the collections of the Queensland Museum indicates that at least two other potential members of the genus exist south of the Great Dividing Range between Dalby and Dulacca, south-east Queensland (SEQ). These species also appear to be under threat of extinction because of land clearing (Stanisic, pers obs.).

The boggomoss snail is a medium-sized snail characterised by a relatively thin, semi-transparent shell. The shell is almost flat with a slightly elevated spire and very small central depression. Shell diameter is between 21 and 26 mm, shell height is between 14 and 16 mm. Shell colour is light-brown to horn with a slight yellowish-green tinge. The animal is grey with a mustard coloured mantle and distinct irregular black blotches on the lung roof that are visible through the shell. The shell surface appears smooth, but microscopically shows a series of covering ridglets that bear a fine elongate scale in fresh specimens (see Stanisic, 1996 for a more detailed description).

2.2. Life history and ecology

There is nothing known of the life history of the boggomoss snail. However there are estimates of life spans of 10-20 years for camaenids (land snails) in arid parts of northern Australia (Solem, 1992). It is reasonable to suggest that the boggomoss snail has similar longevity.

The snail is a free sealer i.e it lies free in the litter or soil under logs, sealing its aperture with a calcified mucous covering called an epiphragm (analogous to the operculum of marine species) while it aestivates (hibernates) during very dry periods. The epiphragm offers protection from desiccation. In semi arid and arid areas snails aestivate through many months of dry while they await the return of the wet season. The epiphragm is porous and is discarded with the onset of favourable conditions.

No specific predators of the boggomoss snail are known, however, rats, birds, beetles, ants and other snails prey on land snails and these agents are present in the boggomoss snail's habitat.

The snail appears restricted to alluvial flats and riparian environments between Taroom and Theodore. In spite of intensive field surveys conducted by staff of the Queensland Museum during 1993-1998, the snail was not found in either the surrounding brigalow communities or the scattered vine thickets that still exist in the area.

Much of the soil in this area is well-drained brown/grey clay derived from basalt. The boggomosses are a series of small peat bogs fed by aquifers of the Great Artesian Basin (Fensham, 1998). These mound springs create perennially moist environments, adjoining the springs that are dominated by a peculiar local array of flora that includes ferns, sedges, leptospermums, tall eucalypts and some remnant rainforest species. This vegetation provides for a healthy layer of leaf litter in some places. The snail lives in litter at the bases of sandpaper figs adjacent to the boggomoss on Mt Rose Station and under logs among dense vegetation at the Isla-Delusion crossing site. Fundamentally, the snail requires moist microhabitat in which to carry on its life cycle.

In central and Western Australia camaenids inhabit many parts of the arid zone whereas in eastern Australia most live in the moister coastal forests. *Adclarkia dawsonensis* is one of a select band of camaenids that inhabit semi arid country in Queensland. Solem (1992) postulated that colonisation of eastern South Australia by the Camaeninae was from the north through what is now central inland Queensland and then through western New South Wales. The boggomoss snail has a number of anatomical and shell features that relate it to the South Australia camaenids grouped under *Cupedora*. As such, the species is an important evolutionary link in the history of this family in eastern Australia's drier habitats (Stanisic, 1996).

2.3. Distribution

Living populations of *Adclarkia dawsonensis* are currently known from only two localities in the Greater Taroom area. One is situated adjacent to a boggomoss (artesian spring) on Mt Rose Station while a second, possibly more robust population is present on a camping and water reserve on the Isla-Delusion crossing of the Dawson River approximately halfway between Taroom and Theodore. A third record of the species derives from a sub-adult dead shell found on the edges of Cockatoo Creek to the south of Taroom. No living specimens were found here despite an intense search. However, the condition of the shell indicated that the occupant had died recently. Compared with the other two sites the condition of this locality is poor with extensive adjacent clearing apparent. The status of this possible population is unknown. Figure 1 provides a map of these localities.

Before 1995, only two specimens of the species were known from shells in collection of the Queensland Museum. These had been collected in the mid-1970's 'near Theodore' by a non-snail specialist. Surveys in the Theodore area by the author during the early to mid 1990's as part of a wider survey of snails in the Queensland Brigalow Lands (Stanisic, 1998) had failed to locate living specimens of the species.

Queensland Museum records for the boggomoss snail are as follows [SC = live collected, RC = dead shell]:

All SEQ. QMMO4239, 1RC, Theodore, Dawson Valley; QMMO6779, 1RC, Theodore, Dawson Valley; QMMO56280, 3SC/13RC, Taroom, c.45km NE on Mt Rose Station, 23.v.1995; QMMO56284, 1SC/1RC, Taroom, c.45km NE on Mt Rose Station, 23.v.1995; QMMO56289, 1SC/8RC, Taroom, c.45km NE on Mt Rose Station, 11.vii.1995; QMMO60756, 17RC, Taroom, c.45km NE on Mt Rose Station, 17.vi.1996; QMMO60804, 1RC, Taroom, E, on Cracow Rd at Cockatoo Ck, 20.vi.1996; QMMO60826, 7SC/8RC, Taroom, NE, at Mt Rose Station, 10.ix.1996; QMMO60852, 6SC/4RC, Dawson River crossing on Isla-Delusion Rd, 4.ii.1997; QMMO64383, 1RC, Dawson River crossing on Isla-Delusion Rd, 20.viii.1997.

There are no other museum records.

2.4. Habitat critical to the survival of the species

Based on knowledge of the species' current distribution in the Taroom area the boggomoss snail appears to prefer alluvial flats along drainage lines (Stanisic, 1996). Grassy eucalypt woodland dominates this 'frontage' country (Speck, 1968). This landscape equates to Regional Ecosystems (REs) 11.3.3 and 11.3.4 of Sattler and Williams (1999). These are described as forests and grassy woodland to open woodland of *Eucalyptus tereticornis*, *E. camaldulensis* and *E. coolabah* on Cainozoic alluvial plains. Closer to the drainage line, the same species occur with a distinct mid and lower storey of sandpaper figs and the 'Rare' Carnavon fan palm *Livistona nitida*. This community is best described as RE 11.3.25. The Camping and Water Reserve at the Isla-Delusion Rd crossing of the Dawson River is the last relatively undisturbed vestige (43.3ha) of both habitat types in the area grading from coolibah woodland on the higher terrace to the stream edge of the Dawson River.

The boggomoss snail locality records highlight an important secondary epicentre for the species, which in the context of the vast clearing that has taken place in this part of the Brigalow Belt bioregion, is now probably an important part of the species' long-term viability. Stanisic (1996) considered the periodic 'break out' flooding that happens in this part of the Dawson River as probably an important dispersal agent for the snail, which will opportunistically colonise any preferred habitat. The perennially wet boggomosses that support comparatively dense vegetation with a complex litter layer provide such a habitat. A number of suitable boggomoss habitats exist on Mt Rose Station but only one is a known habitat for the snail.

That the boggomoss population is able to exist in such a small piece of marginalised habitat is indicative of the small amount of habitat needed by invertebrates in contrast to vertebrates for continued survival.

2.5. Important populations

The only known living populations of the boggomoss snail occur adjacent to a boggomoss on Mt Rose Station (25 27' 14"S, 150 01' 45"E) and at the Camping and Water Reserve at the Isla-Delusion crossing (25 11' 01"S, 150 10' 57"E) of the Dawson River. Both are considered significant for the long term viability of the species.

It is difficult to estimate the sizes of these two populations of the boggomoss snail because of the complex nature of the microhabitat in which the snail lives. Any abundance study would require considerable interference with the habitat (turning logs, raking litter) and would be destructive to both the snail and other biota. However

given the comparative size of the two significant habitats and taking into account search results to date, an estimate is given. The boggomoss site is approximately 0.5ha and probably harbours less than 100 individuals (juveniles, subadults and adults) while the camping and water reserve (c.43ha) probably harbours less than 500 individuals. It is not known what constitutes a viable population, however the presence of subadults and juveniles is indicative of a breeding population.

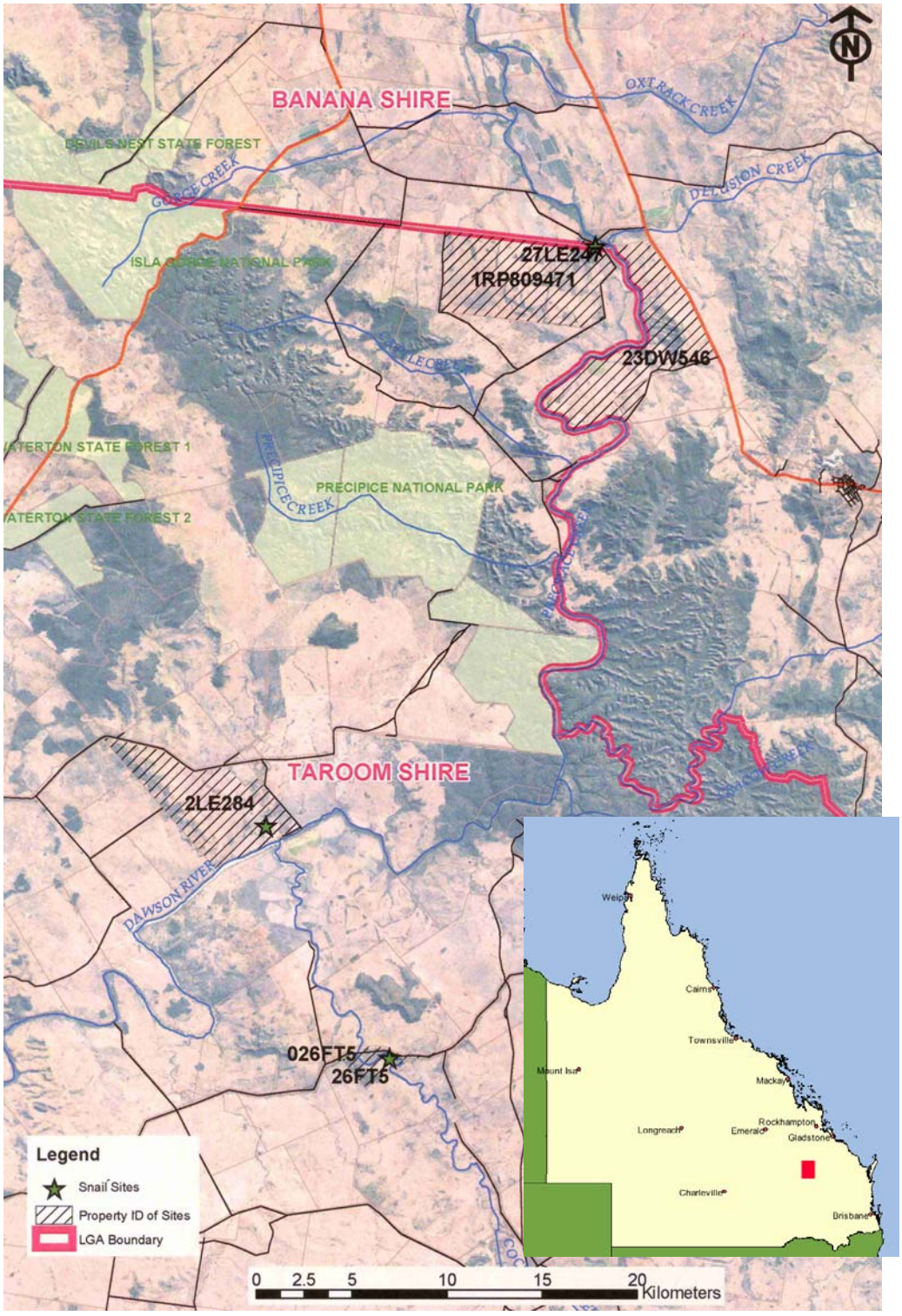

Figure 1. Map of boggomoss snail distribution

3. Threats

3.1. Biology and ecology relevant to threats

Key habitat requirements for the boggomoss snail are a well developed leaf litter layer for food, shelter and breeding sites, and a good coverage of vegetation to support the leaf litter environment and maintain a moist microclimate.

3.2. Identification of threats

It is difficult to accurately speculate on the previous abundance (distribution) of the species. However, given the snail's preference for alluvial flats adjacent to the drainage lines, and the fact that this habitat was once more widespread in the Taroom-Theodore area it is reasonable to assume that the species was also once more widespread. Within the alluvial flat ecosystem, the boggomosses provide additional moist microhabitats that would be ideal microhabitat for the snail. These boggomosses represent the surviving vestiges of a moister land form and it is thought that the entire alluvial flat ecosystem was once the snail's preferred habitat.

Land clearing

The major cause for the decline of the boggomoss snail is habitat loss caused by land clearing which has taken a heavy toll on the Brigalow Belt (Sattler and Webster, 1984). The Regional Ecosystems covering the Mt Rose boggomoss and the Camping and Water Reserve are both listed as having a biodiversity status of 'Of Concern'. This status is accorded due to the extent of clearing (less than 30 percent remaining) of REs 11.3.3 and 11.3.4 and to the perceived threat to the riparian habitat (RE 11.3.25) from weeds, grazing and water management issues.

Fire

Fire is also a major threat to the viability of land snail populations (Stanisic and Ponder, 2004). Since these remnants are small, they are particularly prone to destruction by fire. Fire affects both the snail directly (incineration, dehydration) and indirectly through the destruction of microhabitat (litter and logs). Fires from lightning strikes are common in the Taroom-Theodore area during the storm season and the peat in the boggomosses can provide a powerful fuel. The dense palm forests can carry a heavy fire due to the high biomass of accumulated palm leaves.

Grazing

Activities permitted on the Camping and Water Reserve includes cattle grazing and quarrying. Both cause habitat destruction and ultimately will cause a decline in snail numbers. Cattle grazing is particularly destructive at the snail's microhabitat level in the litter zone. The compression of litter and direct trampling of snails are both significant threats to its continued existence. Through a local agreement between EPA and the landowner, the boggomoss on Mt Rose Station has been fenced thus excluding cattle. However, the result is higher fuel loads through the growth of grasses and a greater risk of wildfire.

Weed infestation

Weeds have the potential to alter both the lower shrub layer and consequent litter as well as contributing to an increased fuel load.

Earthworks

Earthworks can comprise activities such as wide scale quarrying or smaller scale earthmoving associated with roadworks. Both have the potential to affect the snail habitat either directly by removal or by associated run-off from operations.

Changes to hydrology
Changes to hydrology in the local area, by a structure such as a dam or weir, could have serious consequences for the boggomoss snail. Impoundment could cause inundation of the snail's boggomoss habitat while the interruption of normal river flows could have the potential to dry the riparian vegetation community.

3.3. Areas under threat

The two areas under threat from the above processes are the boggomoss on Mt Rose Station and the Camping and Water Reserve at the Isla Delusion Road crossing of the Dawson River.

3.4. Populations under threat

Both significant populations of the boggomoss snail are under threat from processes outlined above. Of most concern is the Camping and Water Reserve population that represents the last known population of the snail in a large tract of preferred habitat. The need to exclude cattle and secure less threatening tenure over this piece of land is considered essential for the survival of the species.

4. Objectives, performance criteria and actions

4.1 Overall objective

The overall objective of this recovery plan is to promote the recovery of the boggomoss snail in the wild.

4.2 Specific objectives, performance criteria and actions

Objective 1. Protect the boggomoss snail habitat to ensure survival of the species.

Action 1.1: Undertake field surveys to assess weed problems in the two known habitats of the boggomoss snail and develop and implement control programmes, if necessary. Use of chemicals to be avoided.
Performance criterion: A weed assessment report is written and, if required, a weed management plan is written and implementation is reported on.
Justification: Weed infestation has the potential to alter both the lower shrub layer and consequent litter as well as contributing to an increased fuel load.

Action 1.2: Develop and implement fire risk management plans for the two known habitats of the boggomoss snail.
Performance criterion: There is an appropriate fire regime that maximises the survival of the snails. Fire management plans for the two sites are written and implementation is reported in annual and final recovery plan reports.
Justification: Fire is a major threat to the viability of land snail populations and the small size of the habitats makes them particularly prone to destruction by fire. Fire affects both the snail directly and indirectly through the destruction of microhabitat.

Action 1.3: Undertake field surveys to identify and map all essential habitat and habitat critical to the survival of the boggomoss snail.
Performance criterion: A map is produced detailing essential habitat and habitat critical to the survival of the species.
Justification: Mapping is an essential tool for managing spatial data.

Action 1.4: Fence the habitat critical to the survival of the boggomoss snail to exclude cattle.
Performance criterion: Fencing is erected around the snail's habitat that will eliminate the threat of animals being trampled and compression of leaf litter.
Justification: Direct trampling of snails and the compression of litter by cattle are both significant threats to its continued existence.

Action 1.5: Develop and implement a post-fencing fire and weed management plan*.*
Performance criterion: Fire and weed management plans for areas post-fencing are written and implementation is reported on, in annual and final recovery plan reports.
Justification: Fencing to exclude cattle may result in higher fuel loads through growth of grasses and weeds and result in a greater risk of wildfire.

Objective 2. Protect populations of the boggomoss snail.

Action 2.1: Review the conservation status of the boggomoss snail under the* Queensland *Nature Conservation Act 1992.
Performance criterion: Production of nomination to change the conservation status of the species, if deemed appropriate.

Justification: To maximise the protection of the boggomoss snail on the Camping and Water Reserve (RES 43) at the Isla-Delusion Road crossing of the Dawson River and throughout its range.

Action 2.2: Enter into negotiations with owners of the Mt Rose Station to protect the population of snails through a conservation covenant such as a Nature Refuge agreement or another voluntary conservation agreement.
Performance criterion: A voluntary conservation agreement is signed.
Justification: To maximise the protection of boggomoss snails on private land.

Action 2.3: Conduct field investigations to investigate significance of other threats (e.g. predators); develop a management plan; and implement actions identified in the management plan.
Performance criterion: A report (and management plan, if required) is produced on the significance of other threats.
Justification: It is important to better understand the significance of the other threats to determine whether investment in management of these threats is required.

Objective 3: Identify additional living populations of the boggomoss snail in the wild.

Action 3.1: Conduct scientific surveys of the Taroom-Theodore area.
Performance criterion: Knowledge of distribution of the snail has increased and results of survey have been documented in a report.
Justification: Surveys will potentially identify additional boggomoss snail populations and habitat or add confidence that the known populations are the only population.

Action 3.2: If new population/s are discovered, undertake actions to protect them.
Performance criterion: New populations (if discovered) are protected.

Objective 4: Increase understanding of the distribution and ecology of the boggomoss snail.

Action 4.1: Develop specific guidelines for the conduct of research and survey on the boggomoss snail.
Performance criterion: Research and survey guidelines have been produced.
Justification: The use of guidelines will ensure that the survival of the species is not further threatened by undertaking surveys and research.

Action 4.2: Conduct research into the ecology and life cycle of the boggomoss snail.
Performance criterion: Based on the research reports/papers are produced.
Justification: An improved knowledge of ecology of the snail will facilitate better management of the species.

Action 4.3: Monitor the presence or absence of the boggomoss snail twice yearly.
Performance criterion: Reports are produced on population monitoring results every six months.
Justification: Monitoring of the snail will identify any changes in the status of the species and determine the success or failure of management. The monitoring should

occur in early spring and late summer, preferably after rain and will assess the presence or absence of the species in areas of suitable habitat. The surveys would not determine abundance of the snails as this could cause unnecessary disturbance to habitat.

Action 4.4: Undertake genetic research into the living populations of the boggomoss snail in order to determine degree of genetic diversity among populations.
Performance criterion: Results of genetic research written up as a report or paper.
Justification: Improved knowledge of the degree of genetic diversity of the species will facilitate decisions on management.

Objective 5: Increase public awareness of the boggomoss snail.

Action 5.1: Prepare and distribute a community awareness brochure.
Performance criterion: The production of an informative brochure leading to an increased awareness.
Justification: Creating awareness and knowledge of the boggomoss snail could encourage community participation in the recovery of the species.

Action 5.2: Conduct a high profile media campaign about the boggomoss snail.
Performance criterion: Two media articles are produced each year.
Justification: Creating awareness and knowledge of the boggomoss snail could encourage community participation in the recovery of the species.

Action 5.3: Collaborate with landowners with habitat suitable for the boggomoss snail to maintain those areas for the purpose of the conservation of the snail.
Performance criterion: Habitat suitable for the boggomoss snail is protected and maintained.
Justification: Any additional suitable habitat that can be conserved can be repopulated with the snails and will reduce the risk of extinction. Landholders will be encouraged to protect and manage suitable habitat on their land, potentially under voluntary conservation agreements such as nature refuge agreements or the Land for Wildlife program.

***Potential contributors to the actions*:** EPA; DNR&W; Queensland Museum; Rural Fire Service; Fitzroy Basin Association Natural Resource Management Regional body; Conservation groups, Banana and Taroom Shire Councils; Universities and educational institutions.

Table 2. Summary of the specific objectives, performance criteria and relevant actions of the boggomoss snail recovery plan.

Objective	Action	Performance criteria	Priority
1: Protect the boggomoss snail habitat to ensure survival of the species	1.1: Undertake field surveys to assess weed problems in the two known habitats of the boggomoss snail and develop and implement control programmes, if necessary. Use of chemicals to be avoided.	A weed assessment report is written and, if required, a weed management plan is written and implementation is reported on.	1
	1.2: Develop and implement fire risk management plans for the two known habitats of the boggomoss snail.	There is an appropriate fire regime that maximises the survival of the snails. Fire management plans for the two sites are written and implementation is reported in annual and final recovery plan reports.	1
	1.3: Undertake field surveys to identify and map all essential habitat and habitat critical to the survival of the boggomoss snail.	A map is produced detailing essential habitat and habitat critical to the survival of the species.	1
	1.4: Fence the habitat critical to the survival of the boggomoss snail to exclude cattle.	Fencing is erected around the snail's habitat that will eliminate the threat of animals being trampled and compression of leaf litter.	1
	1.5: Develop and implement a post-fencing fire and weed management plan.	Fire and weed management plans for areas post-fencing are written and implementation is reported on, in annual and final recovery plan reports.	1
2: Protect populations of the boggomoss snail	2.1: Review the conservation status of the boggomoss snail under the Queensland *Nature Conservation Act 1992.*	Production of nomination to change the conservation status of the species, if deemed appropriate.	2
	2.2: Enter into negotiations with owners of the Mt Rose Station to protect the population of snails through a conservation covenant such as a Nature Refuge agreement or another voluntary conservation agreement.	A voluntary conservation agreement is signed.	1
	2.3: Conduct field investigations to investigate significance of other threats; develop a management plan; and implement actions identified in the management plan.	A report (and management plan, if required) is produced on the significance of other threats.	1
3: Identify additional living populations of the boggomoss snail in the wild	3.1: Conduct scientific surveys of the Taroom-Theodore area.	Knowledge of distribution of the snail has increased and results of survey have been documented in a report.	2
	3.2: If new population/s are discovered, undertake actions to protect them.	New populations (if discovered) are protected.	1
4: Increase understanding of the distribution and ecology of the boggomoss snail	4.1: Develop specific guidelines for the conduct of research and survey on the boggomoss snail.	Research and survey guidelines have been produced.	2
	4.2: Conduct research into the ecology and life cycle of the boggomoss snail.	Based on the research reports/papers are produced.	2
	4.3: Monitor the presence or absence of the boggomoss snail twice yearly.	Reports are produced on population monitoring results every six months.	1
	4.4: Undertake genetic research into the living populations of the boggomoss snail in order to determine degree of genetic diversity among populations.	Results of genetic research written up as a report or paper.	3
5: Increase public awareness of the	5.1: Prepare and distribute a community awareness brochure.	The production of an informative brochure leading to an increased awareness.	2

Objective	Action	Performance criteria	Priority
boggomoss snail	5.2: Conduct a high profile media campaign about the boggomoss snail.	Two media articles are produced each year.	3
	5.3: Collaborate with landowners with habitat suitable for the boggomoss snail to maintain those areas for the purpose of the conservation of the snail.	Habitat suitable for the boggomoss snail is protected and maintained.	2

5. Management practices

The main threats to the continued existence of the boggomoss snail have been identified as habitat loss due to land clearing (including earthworks such as quarrying and road construction), fire, and cattle grazing and the possible effects of an impoundment causing changes to local water hydrology. Hence management practices critical to the continued survival of the boggomoss snail involve habitat protection and the reduction of associated threats.

5.1. Habitat protection

Land clearing is the single most significant threat to the continued existence of the boggomoss snail. Clearing for farming activities to date has greatly reduced suitable habitat for the species. The continued existence of the snail in very small remnants appears to indicate that its viability can be maintained in small allotments (1-3ha). The size of many of these areas of suitable habitat is too small to be captured in any current ecosystem mapping. Hence, the opportunity for these areas to fall outside land clearing guidelines is great. The identification and specific protection of these habitats as 'essential habitat' for the survival of the snail is paramount.

Habitat protection can be achieved in a number of formal ways. The Mt Rose site and any similar sized sites discovered in the future may be identified as essential habitat for the species and given protection by a conservation covenant such as a Nature Refuge agreement or a voluntary conservation agreement with the owners. The boggomoss site on Mt Rose Station is regarded as an opportunistic colony existing in a very tiny patch of habitat maintained by the existence of an artesian aquifer.

The Isla Delusion site (c.43ha) represents a more robust population given the greater extent of habitat. In order to maximise the potential for this population to continue as a viable population a range of activities need to be specifically excluded from the site. This may be achieved when tenure is renewed, potentially designating the site as a conservation park or resource reserve. A trustee arrangement could be negotiated to manage this site. In addition, identification of these areas as habitat critical to the survival of the species or essential habitat will highlight the need for guidelines restricting or prohibiting certain activities.

5.2. Associated threat reduction

Other threats to survival of the snail include any activities that have the potential to interfere with the snail's microhabitat. These comprise fire, weed proliferation, grazing and earthworks (e.g. quarrying and road construction). Any proposal to construct impoundments on the Dawson River has the potential to affect one population of the boggomoss snail through changes to water flow.

Grazing

Grazing, chiefly by cattle, needs to be eliminated from all boggomoss snail sites. Trampling of the undergrowth and removal of forest floor herbage are detrimental to the snail's existence. Cattle also have the potential to spread weeds and hence increase fuel loads for fires. Fencing of identified habitat is the most effective means of excluding cattle. This however can result in the build up of fuel loads due to weed and grass growth.

Fire
Both areas of boggomoss snail habitat are vulnerable to wildfires and hot burns could cause the demise of the boggomoss snail. Fuel reduction burning by means of 'cool fires' is one means of reducing this risk. Hot fires can eradicate the snail and its microhabitat of litter and fallen logs.

Weeds
An assessment of possible weed problems needs to be undertaken in the two known habitats of the boggomoss snail. Weeds have the potential to affect both the lower shrub layer and litter as well as contributing to an increased fuel load. Weed control measures should include both weed reduction measures and reduction of the potential for weed invasion. The use of chemicals should be avoided.

Earthworks
Earthworks need to be carefully assessed prior to approval and monitored during the construction phase if they are to be conducted in such a way as to interfere with the known habitats for the species.

Inundation and interruption to river flows
There is potential for a dam or a weir built on the Dawson River that could eliminate the Mt Rose boggomoss site (Fensham, 1998). However, it should be possible to relocate the snails from the boggomoss site if a structure was built. Alternative sites would need to be identified. Other areas of suitable habitat still exist in the Taroom-Theodore area and these need to be assessed and managed to ensure their continued suitability. Translocation of snails has been attempted elsewhere with limited success (Sherley, 1994).

Another possible impact of an impoundment on the boggomoss snail would be the effect of the interruption to normal flows that would result from the impoundment. The Isla-Delusion habitat is riparian and probably largely reliant on intermittent inundation for the survival of the ecosystem. Part of a potential dam operation includes the management of environmental flows. These are intended to mimic 'normal flows' within a stream system by regulated release from the dam and their maintenance could be critical to the survival of this downstream community.

6. Costs of recovery

Table 3. Estimated costs ($) of boggomoss snail recovery plan. Costed actions are subject to funding availability and do not include GST.

Recovery Actions	Year 1	Year 2	Year 3	Year 4	Year 5	Total
1. Protect boggomoss snail habitat to ensure survival of the species						
1.1 Undertake field surveys to assess weed problems in the two known habitats of the boggomoss snail and develop and implement control programmes, if necessary. Use of chemicals to be avoided.	$1500	$1500	$2000	$2000	$1000	**$8000**
1.2 Develop and implement fire risk management plans for the two known habitats of the boggomoss snail.	$5000	$0	$0	$0	$0	**$5000**
1.3 Undertake field surveys to identify and map all essential habitat and habitat critical to the survival of the of the boggomoss snail.	$15,000					**$15,000**
1.4 Fence the habitat critical to the survival of the boggomoss snail to exclude cattle.	$1500	$1500	$2000	$2000	$1000	**$8000**
1.5 Develop and implement a post-fencing fire and weed management plan.	$	$	$	$	$	$
2. Protect populations of boggomoss snail						
2.1 Review the conservation status of the boggomoss snail under Queensland *Nature Conservation Act 1992.*	$10,000	$0	$0	$0	$0	**$10,000**
2.2 Enter into negotiations with owners of the Mt Rose Station to protect the population of snails through a conservation covenant such as a Nature Refuge agreement or another voluntary conservation agreement.	$2000	$0	$0	$0	$0	**$2000**
2.3 Conduct field investigations to investigate significance of other threats; develop a management plan; and implement actions identified in the management plan.	$0	$1500	$1500	$1500	$1500	**$6000**
3. Identify additional living populations of boggomoss snail in the wild						
3.1 Conduct scientific surveys of the Taroom-Theodore area	$0	$7000	$5000	$0	$0	**$12,000**
3.2 If new population/s are discovered, undertake actions to protect them.	$	**$**	$	$	$	$
4. Increase understanding of the distribution and ecology of the boggomoss snail						
4.1 Develop specific guidelines for the conduct of research and survey on the boggomoss snail.	$3000	$0	$0	$0	$0	**$3000**
4.2 Conduct research into the ecology and life cycle of the boggomoss snail.	$7000	$3000	$0	$0	$0	**$10,000**
4.3 Monitor the populations of the boggomoss snail twice yearly in early spring and late summer, preferably after rain.	$5000	$0	$0	$5000	$0	**$10,000**
4.4 Undertake genetic research into the living populations of the boggomoss snail in order to determine degree of genetic diversity among populations.	$0	$0	$8000	$0	$0	**$8000**
5. Increase public awareness of boggomoss snail						

Recovery Actions	Year 1	Year 2	Year 3	Year 4	Year 5	Total
5.1 Prepare and distribute community awareness brochure.	$2000	$0	$0	$0	$0	**$2000**
5.3 Conduct a high profile media campaign about the boggomoss snail.	$500	$500	$500	$500	$500	**$2500**
5.4 Collaborate with land owners with habitat suitable for the boggomoss snail to maintain those areas for the purpose of the conservation of the snail.	$0	$0	$20,000	$0	$0	**$20,000**
Annual costs of implementing Recovery Plan	$37,500	$15,000	$39,000	$11,000	$4000	
Total cost of Recovery Plan						**$121,500**

7. Evaluation of the recovery plan

The recovery plan will be reviewed within five years of the date of adoption. The review team will consist of individuals and organisations involved in the recovery process and an independent expert.

An interim review three years from the date of publication of the plan would also be helpful in assessing the progress of the implementation of recovery actions.

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